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CEMEDEF

SN = 53.5

Prob. Set #2

1. Given:

$$b = 20 \text{ mm}$$

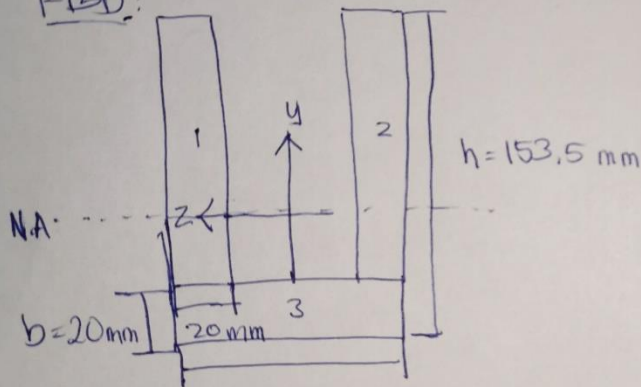
$$h = 100 + 53.5$$

$$= 153.5 \text{ mm}$$

$$w = 100 \text{ mm}$$

Solution:

FBD:



Beam	$I \text{ (mm}^4\text{)}$	A	y	Ay	d	$I + Ad^2$
1	39,654,506.3	2670	86.75	231,622.5	20.91	5,132,849.66
2	3,965,450.63	2670	86.75	231,622.5	20.91	5,132,849.66
3	66,666.67	2000	10	20,000	-55.84	6,302,877.87
Σ		7340		483,245		16,568,577.19

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{483,245}{7340}$$

$$\bar{y} = 65.84 \text{ mm from bottom}$$

$$\sigma_y = \frac{M_y y}{I}$$

$$\sigma_y = \frac{M_y (87.66)}{16,568,577.19}$$

$$M_y = 189,009.55 \text{ } \sigma_y - \text{①}$$

Plastic N.A. :

$$\sum F = 0$$

$$0 = 100(20) \sigma_y + 20(d-20)(2) \sigma_y - 20(153.5-d) 2 \sigma_y$$

$$d = 61.75 \text{ mm from bottom}$$

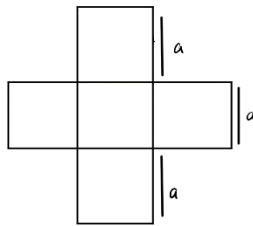
$$M_p = 100(20) \sigma_y (51.75) + 20(41.75)(2) \sigma_y (20.875) + \\ 20(91.75)(2) \sigma_y (45.875)$$

$$M_p = 306,722.5 \sigma_y$$

$$k = \frac{M_p}{M_y} = \frac{306,722.5}{189,009.55}$$

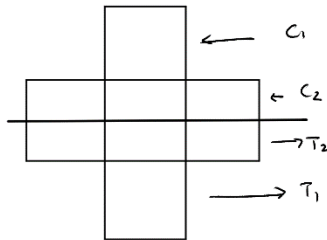
$$k \neq 1.62$$

2.



solving for centroid

	b	h	A	Y	Ad
top	153.5	153.5	23562.25	383.75	9042013.4
bottom	153.5	153.5	23562.25	230.25	16775624
center	460.5	153.5	70686.75	76.75	1808902.7

$$\bar{Y} = \frac{\sum Ad}{\sum A} = 236.25$$


$$E = 20 (1000) \text{ N/mm}$$

$$\sigma_y = 250 \text{ MPa}$$

$$C1 = 250 (153.50) (153.50) = 5890562.5$$

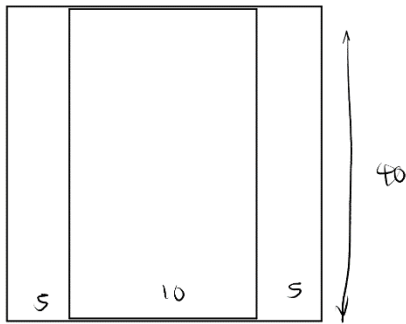
$$C2 = 250 (153.5) (76.75) = 8835843.75$$

$$M_p = 2 (5890562.5) (153.5) + 2 (8835843.75) (38.375)$$

$$M_p = 2486553.695.31 \text{ N-mm}$$

$$M_p = 2486553.695 \text{ N-m}$$

3.



$$NA = 20$$

$$L = 4 + 0.1(5.35)$$

$$L = 9.35 \text{ m}$$

steel $E = 200 \text{ GPa}$

converting steel to brass

brass $E = 100 \text{ GPa}$

$$\frac{200}{100} = 2$$

steel $b = 10(2) \quad h = 40$

brass $b = 5 \quad h = 40$

solving for Inertia

$$I = \frac{20(40^3)}{12} + 2 \frac{(5)(40^3)}{12} = 160000 \text{ mm}^2$$

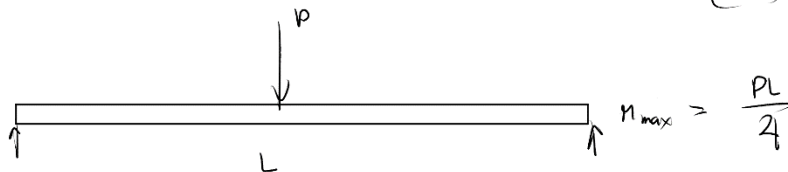
solving for stress

steel (250)

$$\sigma_y = \frac{M_y c}{I} \Rightarrow M_y = \frac{\sigma_y I}{c(N)} = \frac{250(160000)}{2(20)} = 1600000 \text{ N mm}$$

brass (200)

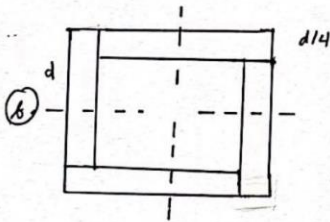
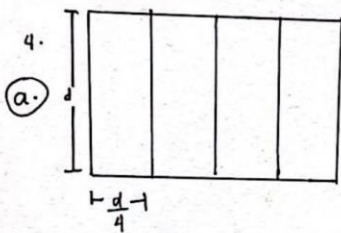
$$\sigma_y = \frac{M_y c}{I} \Rightarrow M_y = \frac{\sigma_y I}{c} = \frac{200(160000)}{(20)} = 1600000 \text{ N mm}$$



using the lowest Moment $M = 1000000$

$$1000000 \text{ N-mm} = \frac{P(4675)}{4}$$

$$P = 427.807 \text{ N}$$



$$a. I_x = I_y = \frac{(d)(d)^3}{12} = \frac{d^4}{12}$$

$$P_{cr} = \frac{\pi^2 EI}{L^2} = \frac{\pi^2 E \frac{d^4}{12}}{L^2}$$

$$b. I_x = I_y = \frac{\left(\frac{5}{4}d\right)^4}{12} - \frac{\left(\frac{3}{4}d\right)^4}{12} = \frac{17}{96} d^4 = \frac{2.125 d^4}{12}$$

$$P_{cr} = \frac{12.125 \pi E d^4}{12 L^2}$$

∴ arrangement b gives a stronger column with respect to buckling
 → b is stronger than a for about 12.125 times.